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**A FORAMINIFERAL FAUNA FROM THE CHAPAPOTE
FORMATION IN MEXICO**

BY

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INTRODUCTION

The Chapapote (1) formation outcrops typically on the Tuxpam river near the village of Chapapote. So far as is known from well-sections and surface samples, the formation is more or less uniform throughout its vertical extent, being composed of grey indurated clays which are very rich in certain pelagic types of foraminifera.

In this paper, it is my endeavor to record most of the important and diagnostic forms. Cushman, in various papers, has described many of the more characteristic ones. But his species, due to the confusion that has existed in the Mexican stratigraphic column, are often listed as typical of certain formations in which they do not occur, or in which they are found only rarely.

The abundance of *Hantkenina alabamensis* Cushman, together with certain other forms, suggests a correlation of the Chapapote with the Upper Eocene (Jackson) of the Gulf States. But to date no Mollusks or other forms have been found in the Chapapote to check the foraminiferal correlation.

As is stated in my discussion of the Guayabal², the Chapapote overlies the Guayabal, from which it is easily distinguished lithologically and faunally.

The Chapapote may be separated readily from the overlying Alazan. The Alazan, in the contact zone above the Chapapote, contains numerous species of *Uvigerina*, many of which are as yet un-named. It also contains such forms as *Bulimina sculptilis* Cushman, *Uvigerina byramensis* Cushman, *Vulvulina spinosa* Cushman, *Planulina mexicana* Cushman, *Globorotalia byramensis* (Cushman) and *Plectofrondicularia alazanensis* Cushman. *Pavonina mexicana* Cushman and *Rectobolivina mexicana* (Cushman) also occur in the lower Alazan zone. The contact of the Chapapote and Alazan extends through the Buena Vista river valley very near the type locality of the Alazan. I have personally collected a sample of undoubted Chapapote age a short way down

¹W. S. Cole, Bull. Amer. Pal., vol. 14, No. 51, p. 7, 1927.

²Idem, p. 7.

stream from the type locality of the Alazan. Mr. Dorr of the Huasteca Petroleum Company has confirmed, by means of well sections, surface samples and the areal geology map, my observations and convictions that the contact of the Alazan and Chapapote formations passes through the Buena Vista river valley.

The Chapapote is equivalent in time to the Tantoyuca³ and should be considered the deep-water phase⁴ of that formation.

The author wishes to acknowledge his indebtedness for various favors and help in connection with the preparation of this paper to Mr. Carroll H. Wegemann, chief geologist of the Pan-American Petroleum and Transport Company, for permission to publish on this material, to Mr. Ellis A. Hall, Mr. John H. Wilson and Mr. James B. Dorr of the Huasteca Petroleum Company for aid in collecting the samples, and also to Mr. Dorr for information as to the stratigraphic position and correlation of the Chapapote with the other Mexican formations.

The samples were examined and this paper was prepared at Cornell University after the writer had resigned from the Huasteca Petroleum Company at Tampico, Mexico, in order to continue his graduate studies in Paleontology.

DESCRIPTION OF SPECIES

FAMILY SACCAMMINIDÆ

GENUS SACCAMMINA W. B. Carpenter, 1869

Saccammina sphaerica G. O. Sars

Plate 3, fig. 15

Saccammina sphaerica G. O. Sars, Forh. Vid. Selsk. Christiania., p. 248, (nomen nudum) 1868 (1869).

Saccammina sphaerica H. B. Brady, Rept. Voy. Challenger, Zoo., vol. 9, p. 253, pl. 18, figs. 11-15, 17, 1884.

Saccammina sphaerica Cushman, Bull. U. S. Nat. Mus., No. 71, pt. 1, p. 39, figs. 33-36, 1910.

This species, found in the Chapapote, agrees very closely with recent forms. It is slightly flattened on one side; otherwise identical with the descriptions and figures given. It is very rare in the Chapapote strata and of no value as a stratigraphic marker.

³W. S. Cole, Bull. Amer. Pal., vol. 14, No. 51, p. 8, 1927.

⁴Personal communication from Mr. James B. Dorr.

FAMILY REOPHACIDÆ

GENUS REOPHAX Montfort, 1808

Reophax nevini n. sp.

Plate 3, fig. 9

Test short, compressed, tapering, consisting of 3-5 chambers, each larger than the preceding one; wall thick, composed of large sand grains, rather rough on the exterior, generally pure white in color; sutures but slightly depressed, more strongly depressed between the last formed chambers; aperture slightly produced.

Length 2.3 mm.

This species is near the recent *R. compressus* Goes, but differs in being less compressed with the sides more tapering. It is named in honor of Dr. C. M. Nevin, Assistant Professor of Structural Geology at Cornell University.

FAMILY AMMODISCIDÆ

GENUS AMMODISCUS Reuss, 1861

Ammodiscus incertus (d'Orbigny)

Operculina incerta d'Orbigny, Foram. Cuba, p. 71, pl. 6, figs. 16, 17, 1839.

Ammodiscus incertus H. B. Brady, Rept. Voy. Challenger, Zoo., vol. 9, p. 330, pl. 38, figs. 1-3, 1884.

Ammodiscus incertus Plummer, Bull. Univ. Texas, No. 2644, pp. 63-64, figs. 1a-d, 1926.

Ammodiscus incertus Cole, Bull. Amer. Pal., vol. 14, No. 51, pp. 10-11, pl. 4, fig. 17, 1927.

This is one of the long ranged Eocene foraminifera in Mexico. It is fairly common in the Chapapote samples, but occurs only rarely in the Guayabal samples. Both the laterally compressed and perfect forms are found in the Chapapote.

FAMILY LITUOLIDÆ

GENUS HAPLOPHRAGMOIDES Cushman, 1910

Haplophragmoides chapapotensis n. sp.

Plate 2, fig. 1

Test comparatively small, coarsely arenaceous, surface rough, close coiled, planospiral, involute, very slightly umbilicate, last formed coil composed of about eight chambers; sutures very indistinct, but the final two generally depressed; periphery broadly rounded; aperture simple at the base of the last formed chamber.

Diameter 0.57 mm.

This species is very near *H. coalingensis* Cushman and Hanna,

but differs in that it has a smaller number of chambers and much rougher finish. It occurs only in the Chapapote according to my studies and determinations.

FAMILY TEXTULARIIDÆ

GENUS TEXTULARIA Defrance, 1824

Textularia chapapotensis n. sp.

Plate 2, fig. 9

Test relatively large, stout, about twice as long as wide; periphery broadly rounded, sutures very slightly depressed, but generally distinct; chambers large, few in number; wall very finely arenaceous with much cement, giving it a very smooth finish; aperture rather large, distinct.

Length 1 mm.

This is a characteristic species which seems to be confined to the Chapapote. Unfortunately, it is rare at all horizons.

Textularia eocæna (Gumbel)

Plate 3, fig. 7

Plecanium eocænium Gumbel, Abh. K. Bay. Akad. Wiss., vol. 10, p. 603, pl. 1, figs. 3, bis, a, b, 1868.

Textularia eocæna Plummer, Bull. Univ. Texas., No. 2664, p. 67, pl. 3, figs. 2a, b, 1926.

There are species in the Chapapote which resemble both Gumbel's and Mrs. Plummer's figures and descriptions. It is rare at all horizons, but easily recognized on account of its large size when present. This species is confined to the Chapapote.

GENUS VULVULINA d'Orbigny, 1826

Vulvulina advena Cushman

Plate 3, fig. 17; Plate 1, fig. 24

Vulvulina advena Cushman, Cont. Cush. Lab. Foram. Res., vol. 2, pt. 2, p. 32, pl. 4, figs. 9a, b, 1926.

Vulvulina cf. *V. spinosa* Cole, Bull. Amer. Pal., vol. 14, No. 51, p. 12, pl. 1, fig. 12, 1927.

Throughout the Chapapote, this form, described by Cushman from the Upper Eocene of Alabama, is commonly present although it is never abundant. It is distinct from *V. spinosa* of the Alazan because it lacks the spinosity of that form.

FAMILY VERNEUILINIDÆ

GENUS TRITAXILINA Cushman, 1911

Tritaxilina mexicana Cushman

Plate 1, figs. 21, 22

Tritaxilina mexicana Cushman, Cont. Cush. Lab. Foram. Res., vol. 1, pt. 3, p. 64, pl. 10, fig. 4, 1925.

Most of the specimens found in the sample from the type locality of the Chapapote appear to be young forms in which the uniserial portion with its terminal mouth has not developed. The adult specimen which I am figuring came from the well, Cerro Azul No. 75 at the depth of 370'. This species, particularly young specimens, is a rare but constant species throughout the Chapapote.

GENUS CLAVULINA d'Orbigny, 1826

Clavulina communis d'Orbigny

Plate 2, figs. 2, 3

Clavulina communis d'Orbigny Ann. Sci. Nat., vol. 7, p. 268, No. 4, 1826.*Clavulina communis* d'Orbigny, Foram. Foss. Bass. Tert. Vienne., p. 196, pl. 12, figs. 1, 2, 1846.

There are found in the Chapapote strata, numerous *Clavulina* forms that resemble *C. communis* very closely. For the present, I am placing my forms under this species noting, however, that the maximum length reached, is only slightly over 1 millimeter and that the test is often rather roughly arenaceous. The Chapapote specimens agree more closely with d'Orbigny's figure in his Vienne Foraminifera, than to those generally given of recent specimens referred to this species.

FAMILY MILIOLIDÆ

GENUS TRILOCULINA d'Orbigny, 1826

Triloculina gibba d'Orbigny

Plate 1, figs. 7, 8

Triloculina gibba d'Orbigny, Foram. Foss. Bass. Tert. Vienne, p. 274, pl. 16, figs. 22-24, 1846.*Triloculina gibba* Hantken, Mitth. Jahrb. ungar. geol. Anstalt., p. 21, pl. 12, fig. 10, 1875.

I am placing under this species with some hesitancy, a form found in the Chapapote. It is very close to d'Orbigny's species.

FAMILY LAGENIDÆ

GENUS LENTICULINA Lamarck, 1804

Lenticulina chapapotensis n. sp.

Plate 1, figs. 14, 15

Test tightly coiled, slightly compressed, about three inflated chambers in the final volution, the last comprising nearly half of

the test; a very narrow keel extending from the aperture to the bottom of the last septal face; aperture produced, radiate.

Length 0.9 mm.

Width 0.63 mm.

This is a very distinct species apparently confined to the Chapapote. In some respects, it resembles *L. beali* (Cushman) from the Miocene of California, but it can be differentiated because of its lack of the angulated sutures and more tightly coiled test.

Lenticulina convergens (Bornemann)

Plate 1, figs. 4, 5

Cristellaria convergens Bornemann, Zeitschi. deutsch. geol. Gesel., vol. 7, p. 327, pl. 13, figs. 16, 17, 1855.

Cristellaria convergens Cushman, Jour. of Pal., vol. 1, No. 2, p. 152, pl. 23, fig. 12, 1927.

This form, which is quite like the species described by Bornemann, occurs very infrequently in the Chapapote. The Alazan forms seem more typical, but the Chapapote specimens are very close and should be referred to the same species. Because of its long range, it is valueless as a stratigraphic marker.

GENUS NODOSARIA Lamarck, 1812

***Nodosaria jacksonensis** Cushman and Applin

Plate 3, fig. 12

Nodosaria jacksonensis Cushman and Applin, Bull. Amer. Assoc. Petrol. Geol., vol. 10, No. 2, p. 170, pl. 7, figs. 14-16, 1926.

Specimens that agree very closely to the species described by Cushman and Applin are found occasionally. This is evidently a wide spread and comparatively long ranged species. While *N. harrisi* of the Guayabal is close to this species, the two can be readily recognized as *N. jacksonensis* is much larger, has the sutures between the chambers more constricted and the initial chambers are slightly different.

Nodosaria sp.

Plate 3, fig. 11

I am figuring this specimen for future reference. There are numerous fragments of this form at some horizons of the Chapapote, but I was unable to secure a perfect specimen.

GENUS ROBULUS Montfort, 1808

Robulus plummeræ n. sp.

Plate 3, fig. 10

Test closely coiled, the length slightly more than the width, strongly keeled, the last formed whorl composed of five chambers; sutures wide, clear, limbate, very gently curved, flush with

the surface and joining at the center to give a very slight suggestion of a knob; aperture radiate above, produced as a slit on the last septal face.

Length 1.32 mm.

Width 1.09 mm.

This species is named in honor of Mrs. Helen J. Plummer.

GENUS HEMICRISTELLARIA Stache, 1864

Hemicristellaria scitula (Berthelin)

Plate 1, fig. 1

Cristellaria scitula Berthelin, Mem. Soc. Geol. de France, ser. 3, No. 1, p. 54, pl. 3, fig. 3, 1880.

Cristellaria scitula Plummer, Bull. Univ. Texas, No. 2644, p. 100, pl. 7, fig. 5, 1926.

This is a very rare species in the Chapapote. I have in my possession only a few specimens for comparison. The Chapapote specimens are very close to both the type of Berthelin and to the one figured by Mrs. Plummer. The chambers of the uncoiling portion are very slightly different in shape. I do not consider the differences strong enough to make this a good variety.

GENUS FISSURINA Reuss, 1850

Fissurina romettensis Saguena

Plate 3, fig. 14

Fissurina romettensis Seguenza, Foram. Monot. Miocene. Messina, p. 70, pl. 2, fig. 42, 1862.

Fissurina romettensis Galloway and Wissler, Jour. of Pal., vol. 1, No. 1, p. 52, pl. 9, fig. 2, 1927.

Occasionally, specimens are found in the Chapapote which may be referred to this species. Unfortunately, the original figure was not at hand and the determination has been made on Galloway and Wissler's description and figures. The only apparent difference is in size; the average of the Chapapote specimens being about 0.58mm. in diameter.

GENUS LAGENA Walker and Jacob, 1798

Lagena sesquistriata Baggs

Plate 2, fig. 8

Lagena sesquistriata Baggs, Bull. U. S. Geol. Survey, No. 513, p. 50, pl. 13, figs. 12-14a, b, 1912.

A form that seems very similar to the one described by Baggs from the Pliocene of California occurs very rarely in the Chapapote. It does not seem to be of any value as a horizon marker on account of its rarity and eccentricity of occurrence.

FAMILY POLYMORPHINIDÆ

GENUS POLYMORPHINA d'Orbigny, 1826

Polymorphina spathulata Terquem

Plate 1, fig. 9

Polymorphina spathulata Terquem, Mem. Soc. Geol. de France, ser. 3, vol. 2, p. 142, pl. 14 (22), fig. 32, 1882.

Polymorphina spathulata Plummer, Bull. Univ. Texas. No. 2644, p. 124, pl. 6, figs. 11a-e, 1926.

A form that seems to be within the variation allowed for this species occurs very infrequently in the Chapapote. For the present, I am referring my specimens to this species.

GENUS DIMORPHINA d'Orbigny, 1826

Dimorphina chapapotensis n. sp.

Plate 2, fig. 4

Test elongate, cylindrical; uniserial portion composed of about two chambers, sutures strongly depressed, especially toward the apertural end; wall coarsely granular; aperture produced.

Length 0.60 mm.

FAMILY NONIONIDÆ

GENUS NONION Montfort, 1808

Nonion chapapotensis n. sp.

Plate 1, figs. 18, 19

Test nearly circular in outline, the periphery broadly rounded; chambers numerous, about eleven in the last formed coil; distinctly umbonate; sutures distinct, limbate, flush with the surface except between the final chambers where they are often slightly depressed; wall smooth, glistening; aperture a low arched slit at the base of the last formed chamber.

Diameter 0.46 mm.

Occasionally, this species shows more chambers on one side than on the other. At first, I thought it should be placed under the Genus *Anomalina*, but after studying a considerable number of specimens, I have placed it under *Nonion*. These specimens are very close to specimens usually referred to *N. depressula*, but I am of the conviction that it should be made a separate form because the chambers are not inflated to give a lobate appearance to the test and the umbilical filling with its stellate extensions is entirely wanting.

Nonion micrus Cole

Nonion micrus Cole, Bull. Amer. Pal., vol. 14, No. 51, p. 22, pl. 5, fig. 12, 1927.

This small species, described from the Guayabal, ranges into the Chapapote where it is abundant at some horizons. There seems to be no variation in form between the Guayabal and Chapapote specimens. It makes an excellent horizon marker on account of its varying abundance.

FAMILY HETEROHELICIDÆ**GENUS SPIROPLECTOIDES** Cushman, 1926**Spiroplectoides annectens** (Parker and Jones)

Textularia annectens Parker and Jones, Ann. and Mag. Nat. Hist., ser. 3, vol. 11, p. 92, fig. 1, 1863.

Spiroplecta annectens H. B. Brady, Rept. Voy. Challenger Zoo., vol. 9, p. 376, pl. 45, figs. 22, 23a, b, 1884.

Specimens that agree very closely with this species, occur infrequently in the Chapapote. I am placing my specimens under this species until opportunity is had to make direct comparison with the type material.

FAMILY HANTKENINIDÆ**GENUS HANTKENINA⁵** Cushman, 1924**Hantkenina alabamensis** Cushman

Hantkenina alabamensis Cushman, Proc. U. S. Nat. Mus., vol. 66, art. 30, p. 3, pl. 1, figs. 1-6, pl. 2, fig. 5, 1924.

Hantkenina alabamensis Cushman and Applin, Bull. Amer. Assoc. Petrol. Geol., vol. 10, No. 2, pp. 177, 178, pl. 10, fig. 3, 1926.

Hantkenina alabamensis Cushman, Cont. Cush. Lab. Foram. Res., vol. 1, pt. 1, p. 7, pl. 1, fig. 11, 1925.

Hantkenina alabamensis Cushman, Cont. Cush. Lab. Foram. Res., vol. 1, pt. 3, p. 68, 1925.

This species is abundant in the sample from the type locality of the Chapapote and is the index fossil of this formation. It can be distinguished readily from *H. brevispina* by its more compressed form and larger spines. It is abundant throughout its range in the Chapapote and is very constant in its characters. Cushman has found this form in the Upper Eocene (Jackson) of Texas and Louisiana. It seems to be restricted to beds of Jackson age both in the United States and Mexico. This species

⁵Note: The various species of *Hantkenina* are well limited and make excellent markers for Mexican formations. *H. alabamensis* and *H. brevispina* are confined to the Chapapote; *H. longispina* to the Guayabal and *H. mexicana* to the un-named formation below the Temporal.

does not range into the Alazan which should be considered Lower Oligocene and not Upper Eocene.

Hantkenina brevispina Cushman

Hantkenina brevispina Cushman, Proc. U. S. Nat. Mus., vol. 66, art. 30, p. 2, pl. 2, fig. 3, 1924.

Hantkenina brevispina Cushman, Cont. Cush. Lab. Foram. Res., vol. 1, No. 1, p. 7, pl. 1, fig. 10, 1925.

This species is also abundant at the type locality of the Chapapote. It is very characteristic and easily distinguished from *H. alabamensis*. This form is confined evidently to the Chapapote. It should prove to be an excellent horizon marker.

FAMILY BULIMINIDÆ

GENUS BULIMINA d'Orbigny, 1826

***Bulimina tuxpamensis* n. sp.**

Plate 1, fig. 23

Test stout, tapering, very regular in outline, broadest near the apertural end, very finely perforate; chambers but slightly inflated, numerous; sutures in most specimens relatively wide, limbate; aperture loop-like or comma shaped, extremely terminal, the most extreme specimens having the aperture almost straight across the end of the test.

Length 0.75 mm.

This *Bulimina* with its regular outline which in some specimens tends to become slightly three sided, is a very good marker for certain horizons of the Chapapote as its vertical range seems to be limited. The figured specimen is from the Huasteca Petroleum Company's well, Cerro Azul No. 75 at the depth of 1040'.

GENUS BOLIVINA d'Orbigny, 1839

***Bolivina jacksonensis* Cushman and Applin**

Bolivina jacksonensis Cushman and Applin, Bull. Amer. Assoc. Petrol. Geol., vol. 10, No. 2, p. 167, pl. 7, figs. 3, 4, 1926.

There are specimens in the Chapapote which agree in every detail with Cushman's and Applin's figures and descriptions of the form found in the Texas Eocene. While these forms are often abundant, in the Chapapote, they are commonly overlooked on account of their small size.

***Bolivina jacksonensis* Cushman and Applin, var. *striatella* Cushman and Applin**

Bolivina jacksonensis Cushman and Applin, var. *striatella* Cushman and Applin, Bull. Amer. Assoc. Petrol. Geol., vol. 10, No. 2, p. 67, pl. 7, figs. 5, 6, 1926.

This variety is associated with the true *B. jacksonensis* in the

Chapapote strata. It is very similar to that form except that the costæ in the Mexican specimens appear to be less numerous and heavier. At some horizons, this form is abundant, but only a few were found in the sample from the type locality.

GENUS UVIGERINA d'Orbigny, 1826

Uvigerina byramensis Cushman, var.

Plate 2, fig. 7

In the Chapapote material, there occur rarely, specimens of *Uvigerina* that may be referred to Cushman's *U. byramensis*. While these specimens agree in general shape and arrangement with *U. byramensis* the last chamber is not quite typical. On account of its small size and great rarity, it is valueless as a stratigraphic marker.

The true *U. byramensis* is found in great numbers in the Alazan strata where it proves to be an excellent marker.

Uvigerina cf. *U. gardneræ* Cushman

Plate 2, fig. 5

Uvigerina gardneræ, Bull. Amer. Assoc. Petrol. Geol., vol. 10, No. 2, p. 175, pl. 8, figs. 16, 17, 1926.

Only one specimen of this species was found in the Chapapote sample from the type locality. It is very close to the one described by Cushman from Texas. While this species is never abundant it is a constant form throughout the Chapapote. Specimens of it are present in nearly all the samples examined.

FAMILY ELLIPSOIDINIDÆ

GENUS PLEUROSOTOMELLA Reuss, 1860

Pleurostomella alternans Schwager

Pleurostomella alternans Schwager, Novara-Exped. Geol. Theil., pt. 2, p. 239, pl. 6, figs. 79, 80, 1866.

Pleurostomella alternans Chapman, Pal. Bull. 11, New Zeal. Geol. Sur., p. 41, pl. 9, fig. 9, 1926.

Pleurostomella alternans Cushman, Cont. Cush. Lab. Foram. Res., vol. 3, pt. 2, p. 129, pl. 25, figs. 7, 8, 28, 1927.

As Cushman has already noted under his discussion of the Genus *Pleurostomella*, the Mexican forms are very similar to *P. alternans*. For the present, it is considered best to place these forms under this species.

GENUS NODOSARELLA Rzehak, 1895

Nodosarella salmojraghii Martinotti

Plate 1, fig. 6

Nodosarella salmojraghii Martinotti, Atti. Soc. Ital. Sci. Nat., vol. 61, pt. 1, p. 347, pl. 7, figs. 58-60, fig. 28 (in text) 1922.

The Chapapote forms of this species seem quite similar to those

figured from Italy. The test of the Chapapote form while having the same number and general arrangement of chambers, differs in not being so straight and also in being slightly stouter.

GENUS ELLIPSONODOSARIA A. Silvestri, 1900

-*Ellipsonodosaria rotundata* (d'Orbigny)

Plate 3, fig. 13

Lingulina rotundata d'Orbigny, Foram. Foss. Bass. Tert. Vienne, p. 61, pl. 2, figs. 48-51, 1846.

Nodosarella rotundata Martinotti, Atti. Soc. Ital. Sci. Nat., vol. 64, p. 178, pl. 4, figs. 18-21, 1925.

This species is identical with the forms found in Europe. It occurs in some abundance at various horizons in the Chapapote. It should prove to be a very good stratigraphic marker as its vertical range appears to be limited.

GENUS DISCORBIS Lamarck, 1808

Discorbis jacksonensis Cushman and Applin

Discorbis jacksonensis Cushman and Applin, Bull. Amer. Assoc. Petrol. Geol., vol. 10, No. 2, p. 178, pl. 9, figs. 8, 9, 1926.

Small forms that may be definitely referred to this species described from the Upper Eocene of Texas are found infrequently in the Chapapote. It is very true to the Texas type.

FAMILY ROTALIIDÆ

GENUS LAMARCKINA Berthelin, 1880

Lamarckina chapapotensis n. sp.

Plate 3, fig. 16

Test nearly circular in outline; periphery slightly lobulate, fairly thin; generally plano-convex; five chambers in the last formed coil; dorsal side evenly convex, ventral side nearly flat to strongly concave; sutures depressed on the ventral side, flush with the surface on the dorsal side; ventrally strongly umbilicate, highly polished; aperture rather large, opening into the umbilicus, hidden by a rather large semicircular lip.

Diameter 0.9 mm.

Of all the described *Lamarckinas*, this species most nearly resembles *L. ocalana* Cushman from the Ocala limestone. It differs from *L. ocalana* in that five chambers in the last formed whorl are constantly present, in that it is not keeled and in that it is concave-convex instead of slightly biconvex. This species, while rare, seems to be confined to the Chapapote.

GENUS GYROIDINA d'Orbigny, 1826

Gyroidina girardana (Reuss)

Rotalina girardana Reuss, Zeitschr. d. Deutsch. Geol. Gesellsch., vol. 3, p. 73, pl. 5, fig. 34, 1851.

Gyroidina girardana Cushman, Jour. of Pal., vol. 1, No. 2, p. 164, pl. 25, figs. 7-9, 1927.

This form in the Chapapote, as has been noted already by Cushman, seems to be identical with Reuss' species. It is rather common at many horizons of the Chapapote and probably extends into the Alazan. It is very near *G. guayabalensis*, but differs in shape and also in having the chambers in the last coil more angulate. It is also considerably larger.

GENUS ROTALIATINA Cushman, 1925

Rotaliatina mexicana Cushman

Plate 3, figs. 3, 4

Rotaliatina mexicana Cushman, Cont. Cush. Lab. Foram. Res., vol. 1, pt. 1, pp. 4, 5, pl. 1, figs. 1a-c, 1925.

This species is very characteristic of the Chapapote. It may be considered one of the index fossils of that formation. While it is never abundant, it always occurs sparingly in samples, at least from the lower upper and middle portions of that formation. Some of the specimens have the spire considerably more elongate but as there are all gradations, the writer does not consider the high spiraled type as a good variety.

GENUS EPONIDES Montfort, 1808

Epinoides umbonata (Reuss)

Plate 2, fig. 6

Rotalina umbonata Reuss, Zeitschr. d. Deutsch. Geol. Gesellsch., vol. 3, p. 75, pl. 5, figs. 35a-c, 1851.

Pulvinulina umbonata Reuss, Denkschi. d. k. Akad. Wiss. Wien., vol. 25, p. 206, 1866.

Pulvinulina umbonata Hantken, Mittheil. Jahrb. d. k. ungar. Geol. Anstalt, vol. 4, p. 77, pl. 9, figs. 8a-c, 1875.

This form seems very close to the European form described by Reuss. For the present, I am placing it under his species.

FAMILY CASSIDULINIDÆ

GENUS PULVINULINELLA Cushman, 1926

Pulvinulinella culter (Parker and Jones) var. **mexicana** Cole

Pulvinulinella culter Cushman, Jour. of Pal., vol. 1, No. 2, p. 167, pl. 26, figs. 8, 9, 1927.

Pulvinulinella culter (Parker and Jones) var. *mexicana* Cole, Bull. Amer. Pal., p. 31, pl. 1, figs. 15, 16, 1927.

This variety described from the Guayabal, extends into and probably through the Chapapote formation. It is not abundant in any of the samples that I have seen, but is persistent throughout its range, from one to ten specimens, occurring in most of the samples studied. It has only slight significance in stratigraphic determinations.

GENUS CASSIDULINA d'Orbigny, 1826

Cassidulina globosa Hantken

Cassidulina globosa Hantken, A Magy. kir. foldt. in. Eukon., vol. 4, p. 54, pl. 16, fig. 2, 1875 (1876).

Cassidulina globosa Hantken, Mittheil Jahrb. d. k. ungar Geol. Anstalt., vol. 4, p. 64, pl. 16, fig. 2, 1875 (1881).

Cassidulina globosa Cushman, Jour. of Pal., vol. 1, No. 2, p. 167, pl. 26, fig. 13, 1927.

Cassidulina globosa Cole, Bull. Amer. Pal., vol. 14, No. 51, p. 32, 1927.

This species of *Cassidulina*, which Cushman has already reported, occurs rarely in the Chapapote. At some horizons, it becomes rather abundant, but in the horizon represented at the type locality of the Chapapote formation, it is rare. It is very constant in form throughout its range in the Mexican Eocene formations.

FAMILY CHILOSTOMELLIDÆ

GENUS CHILOSTOMELLOIDES Cushman, 1926

Chilostomelloides oviformis (Sherborn and Chapman)

Lagena (Obliquina) oviformis Sherborn and Chapman, Jour. Roy. Micro. Soc., p. 745, pl. 14, figs. 19a-d, 1886.

Chilostomella oviformis Sherborn and Chapman, Jour. Roy. Micro. Soc., p. 485, pl. 11, fig. 13, 1889.

Chilostomelloides oviformis Cushman, Cont. Cush. Lab. Foram. Res., vol. 1, pt. 4, p. 77, pl. 11, figs. 17a-d, 21a-c, 1926.

Chilostomelloides oviformis Cushman, Jour. of Pal., vol. 1, No. 2, p. 168, pl. 26, fig. 10, 1927.

Specimens of this species are encountered rarely in the Chapapote. Cushman has listed it from the typical Alazan. I doubt if this species occurs in the Alazan, as I have not seen it in any of the samples which I have regarded as typical Alazan. Although it is rare, it should be a good marker for certain horizons of the Chapapote.

FAMILY GLOBIGERINIDÆ

GENUS GLOBIGERINA d'Orbigny, 1826

Globigerina bulloides d'Orbigny

Globigerina bulloides d'Orbigny, Ann. Sci. Nat., vol. 7, p. 277, 1826.

Globigerina bulloides H. B. Brady, Rept. Voy. Challenger Zoo., vol. 9, p. 593, pl. 77, figs. 3-7, 1884.

This is a common species at some horizons of the Chapapote. It is valueless as a stratigraphic marker on account of its great vertical and horizontal range.

Globigerina cerro-azulensis n. sp.

Plate 1, figs. 11, 12, 13

Test relatively large for the genus, rotaliform, dorsal side very flat, ventral side strongly convex, periphery angulate, chambers few, inflated, about four in the last formed coil, rapidly increasing in size so that the last makes up over one-fourth of the test; sutures distinct, depressed; wall very finely granular; aperture rather large, extending from the periphery to the umbilicus.

Diameter 0.54 mm. Height 0.33 mm.

The erecting of this species required considerable courage on my part, as it is very near the form to which Galloway and Wissler applied the name *G. crassaformis*. It differs from this species in not being umbilicate and in the less angularity of the periphery. The aperture is also larger and the shape of the chambers slightly different.

Globigerina eocæna Gumbel

Plate 1, fig. 20

Globigerina eocæna Gumbel, Abh. k. bay. Akad. Wiss., vol. 10, p. 662, pl. 2, figs. 109a-b, 1868.

The specimens of this form from the Upper Eocene of Mexico are very similar to the species described by Gumbel from the Upper Eocene of the Bavarian Alps. The specimens appear so near like figures given by Gumbel that no differences could be noted.

Globigerina eocænica Terquem

Plate 1, fig. 10; Plate 3, fig. 8

Globigerina eocænica Terquem, Mem. Soc. Geol. de France, ser. 3, No. 2, p. 86, pl. 9, fig. 4, 1882.

This species is very close to the one described by Terquem from the Eocene of France. It is abundant and characteristic of certain horizons of the Chapapote and should make an excellent marker on account of its abundance.

Globigerina inflata d'Orbigny

Globigerina inflata d'Orbigny, Hist. Nat. Isles, Canaries, vol. 2, pt. 2, Forams. p. 134, pl. 2, figs. 7-9, 1839.

Globigerina inflata H. B. Brady, Rept. Voy. Challenger, Zoo., vol. 9, p. 601, p. 79, figs. 8-10, 1884.

Globigerina inflata Cole, Bull. Amer. Pal., vol. 14, No. 51, p. 33, pl. 4, fig. 19, 1927.

Except on the basis of state of preservation, the Guayabal and Chapapote forms of this species can not be distinguished. This

species has a great range in the Tertiary formation of Mexico and elsewhere. It is very abundant at most all horizons. For stratigraphic work, this species has no significance.

Globigerina mexicana Cushman

Plate 2, fig. 11

Globigerina mexicana Cushman, Cont. Cush. Lab. Foram. Res., vol. 1, No. 1, p. 6, pl. 1, figs. 8a, b, 1925.

Globigerina mexicana Cushman, Jour. of Pal., vol. 1, No. 2, p. 168, pl. 26, figs. 16, 17, 1927.

This striking species is confined to the lowest eighty feet of the Chapapote. Its short vertical, but wide horizontal range makes it a splendid marker. In some samples, this form is very abundant. The figured specimen is from the Huasteca well, Cerro Azul No. 75 at 1100

FAMILY ANOMALINIDÆ

GENUS ANOMALINA d'Orbigny, 1826

Anomalina dorri n. sp.

Plate 3, figs. 1, 2

Test nautiloid, slightly asymmetrical, composed of about three coils with 8-10 chambers in the last formed volution; umbilici in most specimens concave, although in some the dorsal umbilicus is slightly convex; wall coarsely perforate; ventrally the sutures raised into distinct welts or ridges which sometimes extend over to the dorsal side, with the exception of the last suture which is generally depressed; dorsally the sutures are flush with the surface or slightly depressed; periphery broadly rounded; aperture a narrow curved slit at the base of the last chamber.

Diameter 1.25 mm.

This *Anomalina* is one of the most striking species of the Chapapote to which it is confined. Although it is rare, it is generally found in samples from all horizons. The highly raised sutures makes this species distinct from all the described species of *Anomalina*.

This species is named in honor of Mr. James B. Dorr, Paleontologist of the Huasteca Petroleum Company at Tampico, Mexico.

Anomalina grosserugosa (Gumbel)

Plate 1, figs. 16, 17

Truncatulina grosserugosa Gumbel, Abh. k. bay. Akad. Wiss., vol. 10, p. 660, pl. 2, fig. 104, 1868.

Anomalina grosserugosa H. B. Brady, Rept. Voy. Challenger, Zoo., vol. 9, p. 673, pl. 94, figs. 4, 5, 1884.

Anomalina grosserugosa Chapman, Proc. Calif. Acad. Sci., ser. 3, vol. 1, p. 253, pl. 30, fig. 9, 1900.

This well known and much described species occurs in the

Chapapote. It follows the type, as described by Gumbel, very closely. It is rather characteristic of the Chapapote, but I cannot say that it is confined to that formation entirely, as I have seen specimens in other Mexican formations that resemble this one closely, but this may have been due to contamination.

Anomalina umbonata Cushman

Anomalina umbonata Cushman, Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 2, p. 300, pl. 7, figs. 5, 6, 1925.

Anomalina umbonata Cushman, Jour. of Pal., vol. 1, No. 2, p. 170, pl. 27, figs. 10, 11, 1927.

Anomalina umbonata Cole, Bull. Amer. Pal., vol. 14, No. 51, p. 35, 1927.

Except in the matter of state preservation, specimens of this species are identical with those from the Moctezuma river and from the type locality of the Guayabal. It is one of the few fossils which occur abundantly in the Guayabal, but extends into the Chapapote. It is very rare in the Chapapote formation and is valueless as a stratigraphic marker.

GENUS CIBICIDES Montfort, 1808

Cibicides tuxpamensis n. sp.

Plate 1, figs. 2, 3; Plate 3, figs. 5, 6

Test large, plano-convex to bi-convex, ventral side very strongly convex; dorsal side only slightly so, 7-9 chambers in the last formed whorl; wall coarsely perforate, sutures limbate especially on the ventral side; flush with the surface, except between the last formed chambers on the dorsal side where they are slightly depressed; a large umbonal mass of clear shell material ventrally; aperture only extending very slightly over on the dorsal side.

Diameter 1.20 mm.

This species differs from the common *Cibicides* in the Guayabal which I have referred to *C. conoideus* Galloway and Wissler, in its greater size, smaller number of chambers in the final volution and its greater biconvexity. I am also figuring slightly smaller specimens which are evidently the megalospheric form of this species.

SOME FURTHER NOTES ON THE GUAYABAL FAUNA

Since the publication of my paper in vol. 14, No. 51, of this Bulletin, I have found the following species which were not previously reported from this formation and one species which it is necessary to revise. The following specimens are all from the sample taken at the type locality of the Guayabal.

Ceratobulimina eximia (Rzehak)

Pulvinulina eximia Rzehak, Ann. K. K. Nat. Hofmuseums, vol. 3, pt. 3, p. 263, pl. 11, figs. 7a-c, 1888.

Ceratobulimina eximia Cushman, Cont. Cush. Lab. Foram. Res., vol. 3, pt. 4, p. 174, pl. 29, figs. 3, 4, pl. 30, figs. 12-16, 1927.

Rotalia dorri Cole. Bull. Amer. Pal., vol. 14, No. 51, p. 29, pl. 4, figs. 5, 6, 1927.

In the paper on the Guayabal, I classified this form under the wrong genus, due to the aperture being broken away. I have had the opportunity, since that time, of examining specimens from the Claiborne of the United States. With a complete series from that formation and a set of younger specimens from the Guayabal, I have been able to correlate it properly under Rzehak's species. The finding of this form helps to substantiate my contention in regard to the age of the Guayabal.

Nodosaria arundinea Schwager

Nodosaria arundinea Schwager, Novara Exped. Geol. Theil., pt. 2, p. 211, pl. 5, figs. 43-45, 1866.

Nodosaria arundinea Cushman and Hanna, Proc. Calif. Acad. Sci., vol. 16, No. 8, p. 215, pl. 13, fig. 14, 1927.

This species has been recorded from the Eocene of Europe and has been found also by Cushman and Hanna in the Eocene of California. It occurs very infrequently in the Guayabal.

Chilostomella ovoidea Reuss

Plate 2, fig. 10

Chilostomella ovoidea Reuss, Denkschr. Akad. Wiss. Wien., vol. 1, p. 380, pl. 48, figs. 12a-e, 1850.

Chilostomella ovoidea Cushman, Cont. Cush. Lab. Foram. Res. vol. 1, pt. 4, p. 74, pl. 11, figs. 1a-e, 1926.

The Guayabal specimens are very near Reuss' species. *Chilostomella ovoidea* is found only infrequently in the Guayabal.

Robulus propinquus (Hantken)

Cristellaria propinqua Hantken, K. ungar. geol. Anstalt, vol. 4, p. 52, pl. 5, fig. 4, (1876 [1881]).

Cristellaria propinqua Cushman and Applin, Bull. Amer. Assoc. Petrol. Geol., vol. 10, No. 2, p. 172, pl. 8, fig. 9, 1926.

The Guayabal specimens appear to be identical with the European and Texas forms. Only a few specimens have been found.

Siphonina claibornensis Cushman

Siphonina claibornensis Cushman, Proc. U. S. Nat. Mus., vol. 72, art. 20, pp. 4-5, pl. 3, figs. 5a-c.

This species occurs rather commonly in the Guayabal where it is associated with *S. tenuicarinata*.

A NEW LEPIDOCYCLINA FROM THE UPPER OLIGOCENE IN MEXICO

Lepidocyclina (Lepidocyclina) waylandvaughani n. sp.; Plate 4, figs. 1-8

Test thin, waferlike without any pronounced umbo; generally flattened, but occasionally slightly sellæform; surface smooth, occasionally obscurely reticulate, especially toward the margins; entirely without papillæ, except a few very small ones which are sometimes present in the umbonal region.

Embryonic chambers nearly equal, separated by a straight wall; outer wall moderately thick, about 0.028mm.; greatest diameter of the embryonic chambers 0.53mm., the least 0.42mm.

Equatorial chambers hexagonal, becoming ogival in the outer rings.

In the vertical section, the number of lateral chambers over the center in the megalospheric form, on each side of the equatorial chambers are 5 to 6, which gradually decrease in number toward the periphery. Equatorial chambers very small at the center, gradually increasing in size as they approach the periphery until they occupy the entire thickness of the test. At the periphery, the equatorial chambers are twice as high as broad. The lateral chambers are low, compressed and relatively thick walled; pillars few and weakly developed.

Diameter of the megalospheric form 8 mm; thickness 0.70 to 0.80 mm.

One form of the species develops lobes to such an extent that it almost forms a cross. All graduations between the perfectly round forms and the extreme development of the "cross" form, may be found, although the lobate forms are rather scarce.

This species is nearest *Lepidocyclina parvula* Cushman, from which it differs in its larger size, more compressed form, weakly developed pillars and finer papillæ.

It occurs in great abundance in a clayey layer above a massive sandstone in a quarry on the Huasteca Petroleum Company's golf course opposite Tampico. The holotype is from this locality. Associated with this form are a few *Lepidocyclina* sp. aff. *L. morgani*, abundant *Rotalia* sp. (figured by Cushman in the Journal of Paleontology Pl. 26, fig. 5) and *Themeon* sp. also abundant. These forms seem to characterize this horizon which from its position may be assumed to be Upper San Rafæl, very near the Miocene contact.

Dr. Vaughan, in whose honor this species was named, was kind enough to examine specimens of this species at my request. He informs me that he has known of this species from Antigua for a number of years. To date, he had not applied a name to it because of his doubt as to its relation to *parvula*. However, he says, "It appears to me to be more closely related to *L. parvula* Cushman, but that species is usually thicker through the center, even to being inflated and the papillæ are coarser. However, there is a tremendous amount of variation. Since I have not yet reached a positive decision regarding what to do with the form, I hesitate to advise you. Because of the two differences above mentioned, I should hesitate to apply the name *parvula* to it, but the form runs very close to the flatter varieties of *parvula*."

In the future, with more work and more specimens, *Lepidocyclina waylandvaughani* may prove to be only a variety of *parvula*, but as the differences noted seem constant for the Mexican forms and the true *parvula* or even anything approaching it have not been found in Mexico to date, the author feels that this form is deserving of specific rank.

***Lepidocyclina* aff. *L. morgani* Lem. and Douvillé**

Plate 4, fig. 9

Lepidocyclina cf. *marginata* H. Douvillé, Bull. Soc. Geol. de France, ser. 3, vol. 18, p. 1001, 1900.

Lepidocyclina morgani Lem. and R. Douvillé, Soc. Geol. de France, Paleont., vol. 12, Mem. 32, p. 17, pl. 1, figs. 12, 15, 17; pl. 2, figs. 4, 12; pl. 3, fig. 2, 1904.

Lepidocyclina morgani Cushman, Carnegie Inst., Washington, Pub. 291, p. 59, pl. 11, figs. 1 to 3, fig. 7, (in text) 1919.

This form seems to be the only other *Lepidocyclina* associated

with *waylandraughani* at the horizon under discussion. It is fairly rare. To date, I have not been able to obtain a megaspheric form, but the microspheric seems very close to *L. morgani*.

MEXICAN FORAMINIFERAL LITERATURE

No attempt has been made to give a complete synonymy, but for the convenience of future workers on the Mexican Foraminifera, a list is given of the papers which have specifically described Mexican forms.

1. Cole, W. S. A Foraminiferal Fauna from the Guayabal Formation in Mexico. Bull. Amer. Pal., vol. 14, No. 51, pp. 1-46, pls. 1-5, 1927.
2. Cushman, J. A. American Species of Orthophragmina and Lepidocyclina. U. S. Geol. Sur. Prof. Paper 125, pp. 39-105, pls. 7-35, 1920.
3. A New Genus of Eocene Foraminifera. Proc. U. S. Nat. Mus. vol. 66, art. 30, pp. 1-4, pls. 1-2, 1924.
4. An Eocene Fauna from the Moctezuma River Mexico. Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 2, pp. 298-303, pl. 6-8, 1925.
5. New Foraminifera from the Upper Eocene of Mexico. Cont. Cush. Lab. Foram. Res., vol. 1, pt. 1, pp. 4-10, pl. 1, 1925.
6. Some New Foraminifera from the Velasco Shale in Mexico. Cont. Cush. Lab. Foram. Res., vol. 1, pt. 1, pp. 18-23, pl. 3, 1925.
7. Notes on the Genus Tritaxilina. Cont. Cush. Lab. Foram. Res., vol. 1, pt. 3, pp. 62-65, pl. 10, 1925.
8. Foraminifera of the Genera Siphogenerina and Pavonia. Proc. U. S. Nat. Mus., vol. 67, art. 25, pp. 1-24, pls. 1-6, 1926.
9. The Foraminifera of the Velasco Shale of the Tampico Embayment, Bull. Amer. Assoc. Petrol. Geol., vol. 10, No. 6, pp. 581-612, pls. 15-21, 1926.
10. Some Fossil Bolivinas from Mexico, Cont. Cush. Lab. Foram. Res., vol. 1, pt. 3, pp. 62-65, pl. 10, 1925.
11. A Peculiar Frondicularia from Mexico and Trinidad, Cont. Cush. Lab. Foram. Res., vol. 1, pt. 4, pp. 88-89, pl. 13, 1926.
12. Some Foraminifera from the Mendez Shale of Eastern Mexico. Cont. Cush. Lab. Res., vol. 2, pt. 1, pp. 16-27, pls. 2, 3, 1926.
13. New and Interesting Foraminifera from Mexico and Texas. Cont. Cush. Lab. Foram. Res., vol. 3, pt. 2, pp. 111-119, pls. 22, 23, 1927.
14. Foraminifera of the Genus Siphonina and Related Genera. Proc. U. S. Nat. Mus., vol. 72, art. 20, pp. 1-15, pls. 1-4, 1927.
15. Some Notes on the Genus Ceratobulimina. Cont. Cush. Lab. Foram. Res., vol. 3, pt. 4, pp. 171-179, pls. 29, 30, 1927.
16. Douvillé, H. Les Orbitoides de la région pétrolifère du Mexique. France, Soc. géol. Compte rend. som., séance, 21 févé. p. 34, 1927.
17. Galloway, J. J. Notes on the Genus Polylepidina and a New Species, Jour. of Pal., vol. 1, No. 4, pp. 299-304, pl. 51, 1928.
18. Vaughan, T. W. American and European Tertiary Larger Foraminifera. Bull. Geol. Soc. of Am., vol. 35, pp. 785-822. pls. 30-36, 1924.

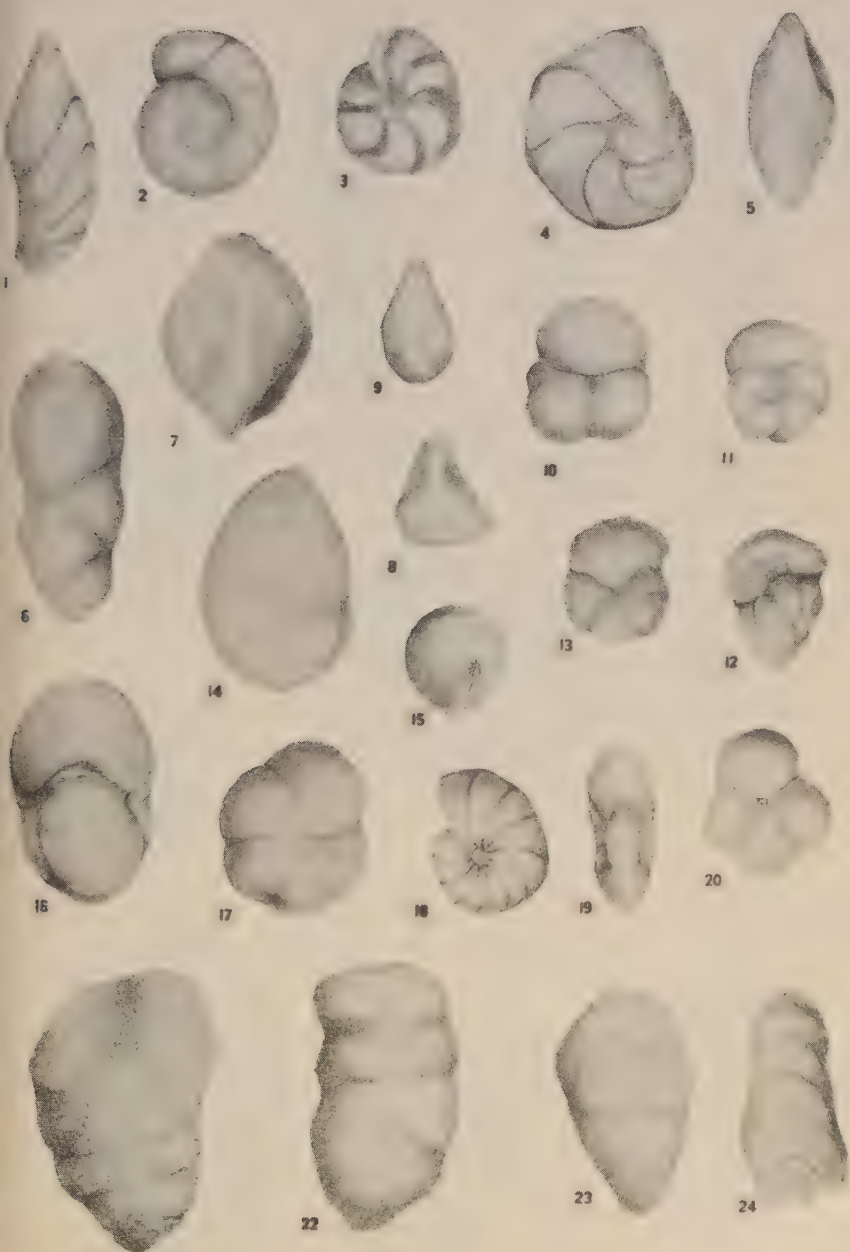
PLATES I - 4

Note: Unless otherwise stated under the description of the species, all the holotypes are from the type locality of the Chapapote. With the exception of the *Lepidocyclina* holotype, all the others have been deposited in the Eocene collection of Professor G. D. Harris at Cornell University. The figured holotypes and paratypes of the *Lepidocyclina*, I am retaining in my personal collection for the present.

Printed plates furnished by Mr. W. S. Cole. -- Eds.

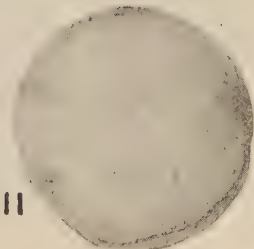
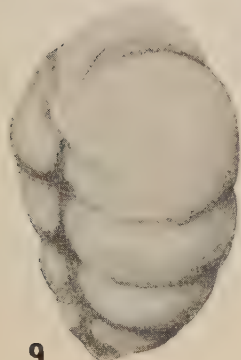
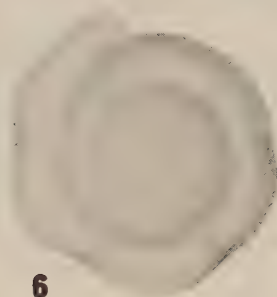
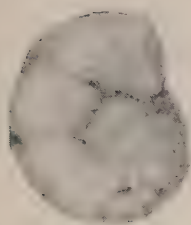
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Explanation of Plate 4

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5. *Lepidocyclina* (*Lepidocyclina*) *waylandvaughani* n. sp. vertical section; diameter of actual specimen 6.5mm.; paratype 21
6. *Lepidocyclina* (*Lepidocyclina*) *waylandvaughani* n. sp; greatly enlarged; diameter of actual specimen 8mm.; holotype 21
7. *Lepidocyclina* (*Lepidocyclina*) *waylandvaughani* n. sp; horizontal section of another paratype; diameter of actual specimen 6.7mm.; 21
8. *Lepidocyclina* (*Lepidocyclina*) *waylandvaughani* n. sp; another horizontal section; diameter of actual specimen 8mm.; paratype 21
9. *Lepidocyclina* aff. *L. morgani* Lem; diameter of actual specimen 5mm. 22
10. *Lepidocyclina* (*Lepidocyclina*) *waylandvaughani* n. sp; vertical section; diameter of actual specimen 6mm.; paratype 21

